APPENDIX A

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(JRMA/JSA)

Rubber, vulcanized or thermoplastic — Determination of hardness

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by the Japan Rubber Manufactures Association (JRMA)/Japanese Standard Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS K 6253** : 1997 is replaced with this Standard.

This Standard has been made based on **ISO 48** : 1994 *Rubber, vulcanized or thermoplastic—Determination of hardness (hardness between 10 IRHD and 100 IRHD)*, **ISO 7619-1** : 2004 *Rubber, vulcanized or thermoplastic—Determination of indentation hardness—Part 1 : Durometer method (Shore hardness)* and **ISO 7619-2** : 2004 *Rubber, vulcanized or thermoplastic—Determination of indentation hardness—Part 2 : IRHD pocket meter method* for the purpose of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

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In the event of any doubts arising as to the contents, the original JIS is to be the final authority.

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Rubber, vulcanized or thermoplastic — Determination of hardness

Introduction This Japanese Industrial Standard has been prepared based on the third edition of **ISO 48** *Rubber, vulcanized or thermoplastic—Determination of hardness (hardness between 10 IRHD and 100 IRHD)* published in 1994 and Amendment 1 published in 1999, the first edition of **ISO 7619-1** *Rubber, vulcanized or thermoplastic—Determination of indentation hardness—Part 1: Durometer method (Shore hardness)* published in 2004, and the first edition of **ISO 7619-2** *Rubber, vulcanized or thermoplastic—Determination of indentation hardness—Part 2: IRHD pocket meter method* published in 2004 with some modifications of the technical contents.

The portions given continuous sidelines or dotted underlines are the matters in which the contents of the original International Standards have been modified. A list of modifications with explanations is given in Annex 3 (informative).

WARNING: Persons using this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices.

1 Scope This Standard specifies the testing methods to measure hardness of vulcanized rubber and thermoplastic rubber.

NOTE : The International Standards corresponding to this Standard are as follows.

In addition, symbols which denote the correspondence in the contents between the relevant International Standards and JIS are IDT (identical), MOD (modified) and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 48 : 1994 *Rubber, vulcanized or thermoplastic—Determination of hardness (hardness between 10 IRHD and 100 IRHD)* and Amendment 1 (MOD)

ISO 7619-1 : 2004 *Rubber, vulcanized or thermoplastic—Determination of indentation hardness—Part 1: Durometer method (Shore hardness)* (MOD)

ISO 7619-2 : 2004 *Rubber, vulcanized or thermoplastic—Determination of indentation hardness—Part 2: IRHD pocket meter method* (MOD)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS K 6200 *Rubber—Vocabulary*

JIS K 6250 *Rubber—General procedures for preparing and conditioning test pieces for physical test methods*

NOTE : **ISO 23529** : 2004 *Rubber-General procedures for preparing and conditioning test pieces for physical test methods* is equivalent to the said standard.

JIS Z 8401 *Guide to the rounding of numbers*

3 Definitions For the purposes of this Standard, the definitions given in **JIS K 6200** and the following definitions apply.

a) **international rubber hardness degrees (IRHD)** the hardness which can be obtained by converting the indentation depth of plunger using the conversion table when the plunger with a ball-type lower end is vertically impressed on the surface of a test piece with a definite of indenting force

A hardness scale is chosen so that "0" represents the hardness of material having a Young's modulus of zero and "100" represents the hardness of material of infinite Young's modulus, and the following conditions are fulfilled over most of normal range of hardness.

1) When the Young's moduli of two test pieces having the difference of one IRHD are compared, the rate is approximately same in most of normal range of hardness.

2) For highly elastic rubbers (the rubbers of which the indicated values are hardly reduced at the time of measuring IRHD after indenting force is loaded), the scales of IRHD and that of Type A durometer are mutually comparable as the common scale.

b) **durometer hardness** the hardness which is obtained from the indentation depth of indentor when the specified shape of indentor is impressed on the surface of test piece with the specified spring force by using the hardness tester called as the durometer

c) **IRHD pocket hardness** the hardness of the international rubber hardness degrees (IRHD) which is obtained from the indentation depth of indentor by using the indication mechanism capable of reading conveniently when the specified shape of indentor is impressed on the surface of test piece with the specified spring force by using the portable hardness tester called as the IRHD pocket hardness meter

d) **standard hardness** the hardness obtained when measurement is carried out by using the test pieces of shape and dimensions satisfying the specifications and by the specified procedures in each test method

e) **apparent hardness** the hardness obtained when measurement is carried out by using the test pieces of shape and dimensions without satisfying the specifications and/or out of accordance with the specified procedures in each test method.

4 Type of test There are many types of testing methods for hardness test and they are classified depending on the principle of measurement, range of measurement, type of testing apparatus and so on. The test result is classified into standard hardness and apparent hardness by shape or dimensions of a test piece. The type of hardness test for vulcanized rubber and thermoplastic rubber shall be shown in table 1.

Table 1 Outline and type of hardness test

Type of test (Principle of measurement)	Range of hardness measurement	Type of testing apparatus	Testing method	Testing piece condition for standard hardness		
				Shape	Thickness mm	Minimum distance from the edge of test piece mm
International rubber hardness degree (Constant-force type)	For normal hardness (30 to 95 IRHD)	Normal size international rubber hardness meter	N method	Both upper and lower surfaces are smooth and parallel to each other	8.0 min.	9.0
					10.0 max.	10.0
	For high hardness (85 to 100 IRHD)	Normal size international rubber hardness meter	H method		8.0 min.	9.0
					10.0 max.	10.0
	For low hardness (10 to 35 IRHD)	Normal international rubber hardness meter	L method		10.0 min.	10.0
					15.0 max.	11.5
	For normal hardness (30 to 95 IRHD)	Micro size international rubber hardness meter	M method		2.0±0.5	2.0
Durometer hardness (Spring type)	For normal hardness (A20 to 90)	Type A durometer			6.0 or more	12.0
	For high hardness (Over A90)	Type O durometer			6.0 or more	12.0
	For low hardness (Under A20)	Type E durometer			10.0 or more	12.0
	For normal hardness (A20 to 90)	Type AM durometer (For microsize test piece)			1.5 or more	4.5
IRHD pocket hardness (Specified force spring type)	For normal hardness (30 to 95 IRHD)	IRHD pocket hardness meter			6.0 or more	12.0

Informative: "Type E durometer" is named as "Type AO durometer" in **ISO 7619-1**.

5 International rubber hardness degree test

5.1 Purpose This test shall be carried out to measure the international rubber hardness degree of vulcanized rubber and thermoplastic rubber.

5.2 Principle This hardness test is carried out so that when a small contact force is given on the surface of rubber test piece via a ball and afterward the total indenting force added by a large indenting force is furthermore given, the difference between the indentation depth of ball by the total indenting force and the indentation depth of ball by contacting force is measured. The international rubber hardness degrees (IRHD) is obtained from the difference of this indentation depth by using table 3, table 4 and table 5.

The value made to be one-sixth of the indentation depth as shown in table 3 is used in M method. The measuring device for indentation depth, which is graduated so that the chart based on these tables or the international rubber hardness degrees (IRHD) can be directly read, may be used. These tables are based on Annex A.

5.3 Range of measurement The measuring range of this test is divided according to the hardness of a test piece. The measuring range of each testing method is as shown in **a)** to **d)** and figure 1.

a) **N method** Standard measuring range shall be hardness of 35 IRHD to 85 IRHD. It is permissible to hardness of 30 IRHD to 95 IRHD(1).

b) **H method** Standard measuring range shall be hardness of 85 IRHD to 100 IRHD.

c) **L method** Standard measuring range shall be hardness of 10 IRHD to 35 IRHD.

d) **M method** Standard measuring range shall be hardness of 35 IRHD to 85 IRHD. It is permissible to hardness of 30 IRHD to 95 IRHD(2).

Notes (1) The hardness values in 85 IRHD to 95 IRHD and 30 IRHD to 35 IRHD obtained by N method do not always coincide with the values by H method and L method.

(2) The testing apparatus for M method is the one prepared by miniaturizing the testing apparatus for N method by about one-sixth to measure the test piece with thin thickness, therefore the plunger indentation depth by M method is just one-sixth that by N method. The results given by M method are not always coincident with the results given by N method because of the surface effect of rubber or slight roughness of the surface.

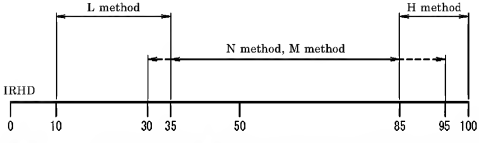


Figure 1 Application range of international rubber hardness degrees (IRHD) hardness measurement

5.4 Testing apparatus The testing apparatus is composed of a holding base for test piece by which a test piece is kept, an annular pressure foot by which the surface of a test piece is impressed, a plunger with a ball-type lower end set at the centre of hole of pressure foot, a device for loading which gives an indenting force on a plunger to make an indentation on a test piece and a measuring device to measure an indentation depth impressed on a test piece. A vibrating device to lessen the influence of friction on the contact part should be installed. A thermostat may be provided for measuring a test temperature other than standard condition of laboratory. The dimensions of main parts and the specification of force are shown in table 2.

Table 2 Main dimensions and forces of testing apparatus

Type of tests	Diameter of ball of plunger end mm	Pressure foot			Force applying at ball of plunger end		
		Diameter mm	Diameter of hole mm	Force exerted on pressure face	Contact force (3)	Indenting force (4)	Total
N method	2.50±0.01	20±1	6±1	8.3±1.5 N	0.30±0.02 N	5.40±0.01 N	5.70±0.03 N
H method	1.00±0.01	20±1	6±1				
L method	5.00±0.01	22±1	10±1				
M method	0.395±0.005	3.35±0.15	1.00±0.15	235±30 mN	8.3±0.5 mN	145±0.5 mN	153.3±1.0 mN

Notes (3) Contact force means the force causing the end ball of a plunger to contact with surface of a test piece.

(4) Indenting force means the force to impress the end ball of a plunger into test piece after making contact.

5.4.1 Plunger A plunger shall have a ball-type lower and specified in table 2 and be kept vertical to the pressure face. The lower end ball of a plunger shall be kept a little upper than the face of pressure foot before contact force is applied.

5.4.2 Loading device A loading device shall accurately apply the contact force and indenting force specified in table 2 to the end ball of a plunger.

5.4.3 Measuring device of indentation depth The measuring device for indentation depth shall be capable of measuring indentation depth of a plunger when indenting force is applied to a plunger, by which the indentation depth or IRHD shall be directly read(5). The conversion from indentation depth to IRHD can be done through table 3, table 4 and table 5(6).

Notes (5) For the measuring device of indentation depth, any of mechanical, optical, or electrical, is serviceable.

(6) Table 3 is for the conversion of N method, table 4 for H method and table 5 for L method. In case of M method, convert after making the indented depth shown in table 3 one-sixth.

5.4.4 Pressure foot An annular pressure foot makes a right angle with the plunger. The diameter of pressure foot and the diameter of the hole for a plunger are as specified in table 2. When the force exerted on the pressure foot is as specified in table 2, the pressure impressed on the surface of test piece becomes (30±5) kPa. In order to measure the relative displacement between the pressure foot and the plunger, the pressure foot shall be firmly united with the measuring device of the indentation depth.

Table 3 Conversion table from indentation (*D*) of a plunger to international rubber hardness degrees (IRHD) (N method)

D mm	International rubber hardness degrees IRHD	*D* mm	International rubber hardness degrees IRHD	*D* mm	International rubber hardness degrees IRHD	*D* mm	International rubber hardness degrees IRHD
0.00	100.0	0.45	73.9	0.90	52.3	1.35	38.9
0.01	100.0	0.46	73.3	0.91	52.0	1.36	38.7
0.02	99.9	0.47	72.7	0.92	51.6	1.37	38.4
0.03	99.8	0.48	72.2	0.93	51.2	1.38	38.2
0.04	99.6	0.49	71.6	0.94	50.9	1.39	38.0
0.05	99.3	0.50	71.0	0.95	50.5	1.40	37.8
0.06	99.0	0.51	70.4	0.96	50.2	1.41	37.5
0.07	98.6	0.52	69.8	0.97	49.8	1.42	37.3
0.08	98.1	0.53	69.3	0.98	49.5	1.43	37.1
0.09	97.7	0.54	68.7	0.99	49.1	1.44	36.9
0.10	97.1	0.55	68.2	1.00	48.8	1.45	36.7
0.11	96.5	0.56	67.6	1.01	48.5	1.46	36.5
0.12	95.9	0.57	67.1	1.02	48.1	1.47	36.2
0.13	95.3	0.58	66.6	1.03	47.8	1.48	36.0
0.14	94.7	0.59	66.0	1.04	47.5	1.49	35.8
0.15	94.0	0.60	65.5	1.05	47.1	1.50	35.6
0.16	93.4	0.61	65.0	1.06	46.8	1.51	35.4
0.17	92.7	0.62	64.5	1.07	46.5	1.52	35.2
0.18	92.0	0.63	64.0	1.08	46.2	1.53	35.0
0.19	91.3	0.64	63.5	1.09	45.9	1.54	34.8
0.20	90.6	0.65	63.0	1.10	45.6	1.55	34.6
0.21	89.8	0.66	62.5	1.11	45.3	1.56	34.4
0.22	89.2	0.67	62.0	1.12	45.0	1.57	34.2
0.23	88.5	0.68	61.5	1.13	44.7	1.58	34.0
0.24	87.8	0.69	61.1	1.14	44.4	1.59	33.8
0.25	87.1	0.70	60.6	1.15	44.1	1.60	33.6
0.26	86.4	0.71	60.1	1.16	43.8	1.61	33.4
0.27	85.7	0.72	59.7	1.17	43.5	1.62	33.2
0.28	85.0	0.73	59.2	1.18	43.3	1.63	33.0
0.29	84.3	0.74	58.8	1.19	43.0	1.64	32.8
0.30	83.6	0.75	58.3	1.20	42.7	1.65	32.6
0.31	82.9	0.76	57.9	1.21	42.5	1.66	32.4
0.32	82.2	0.77	57.5	1.22	42.2	1.67	32.3
0.33	81.5	0.78	57.0	1.23	41.9	1.68	32.1
0.34	80.9	0.79	56.6	1.24	41.7	1.69	31.9

Table 3 (concluded)

D mm	International rubber hardness degrees IRHD	*D* mm	International rubber hardness degrees IRHD	*D* mm	International rubber hardness degrees IRHD	*D* mm	International rubber hardness degrees IRHD
0.35	80.2	0.8	56.2	1.25	41.4	1.70	31.7
0.36	79.5	0.81	55.8	1.26	41.1	1.71	31.6
0.37	78.9	0.82	55.4	1.27	40.9	1.72	31.4
0.38	78.2	0.83	55.0	1.28	40.6	1.73	31.2
0.39	77.6	0.84	54.6	1.29	40.4	1.74	31.1
0.40	77.0	0.85	54.2	1.30	40.1	1.75	30.9
0.41	76.4	0.86	53.8	1.31	39.9	1.76	30.7
0.42	75.8	0.87	53.4	1.32	39.6	1.77	30.5
0.43	75.2	0.88	53.0	1.33	39.4	1.78	30.4
0.44	74.5	0.89	52.7	1.34	39.1	1.79	30.2
						1.80	30.0

Table 4 Conversion table from indentation (*D*) of a plunger to international rubber hardness degrees (IRHD) (H method)

D mm	International rubber hardness degrees IRHD	*D* mm	International rubber hardness degrees IRHD	*D* mm	International rubber hardness degrees IRHD
0.00	100.0	0.15	97.3	0.30	91.1
0.01	100.0	0.16	97.0	0.31	90.7
0.02	100.0	0.17	96.6	0.32	90.2
0.03	99.9	0.18	96.2	0.33	89.7
0.04	99.9	0.19	95.8	0.34	89.3
0.05	99.8	0.20	95.4	0.35	88.8
0.06	99.6	0.21	95.0	0.36	88.4
0.07	99.5	0.22	94.6	0.37	87.9
0.08	99.3	0.23	94.2	0.38	87.5
0.09	99.1	0.24	93.8	0.39	87.0
0.10	98.8	0.25	93.4	0.40	86.6
0.11	98.6	0.26	92.9	0.41	86.1
0.12	98.3	0.27	92.5	0.42	85.7
0.13	98.0	0.28	92.0	0.43	85.3
0.14	97.6	0.29	91.6	0.44	84.8

Table 5 Conversion table from indentation (*D*) of a plunger to international rubber hardness degrees (IRHD) (L method)

D mm	International rubber hardness degrees IRHD	D mm	International rubber hardness degrees IRHD	D mm	International rubber hardness degrees IRHD
1.10	34.9	1.80	21.3	2.50	14.1
1.12	34.4	1.82	21.1	2.52	14.0
1.14	33.9	1.84	20.8	2.54	13.8
1.16	33.4	1.86	20.6	2.56	13.7
1.18	32.9	1.88	20.3	2.58	13.5
1.20	32.4	1.90	20.1	2.60	13.4
1.22	31.9	1.92	19.8	2.62	13.3
1.24	31.4	1.94	19.6	2.64	13.1
1.26	30.9	1.96	19.4	2.66	13.0
1.28	30.4	1.98	19.2	2.68	12.8
1.30	30.0	2.00	18.9	2.70	12.7
1.32	29.6	2.02	18.7	2.72	12.6
1.34	29.2	2.04	18.5	2.74	12.5
1.36	28.8	2.06	18.3	2.76	12.3
1.38	28.4	2.08	18.0	2.78	12.2
1.40	28.0	2.10	17.8	2.80	12.1
1.42	27.6	2.12	17.6	2.82	12.0
1.44	27.2	2.14	17.4	2.84	11.8
1.46	26.8	2.16	17.2	2.86	11.7
1.48	26.4	2.18	17.0	2.88	11.6
1.50	26.1	2.20	16.8	2.90	11.5
1.52	25.7	2.22	16.6	2.92	11.4
1.54	25.4	2.24	16.4	2.94	11.3
1.56	25.0	2.26	16.2	2.96	11.2
1.58	24.7	2.28	16.0	2.98	11.1
1.60	24.4	2.30	15.8	3.00	11.0
1.62	24.1	2.32	15.6	3.02	10.9
1.64	23.8	2.34	15.4	3.04	10.8
1.66	23.5	2.36	15.3	3.06	10.6
1.68	23.1	2.38	15.1	3.08	10.5
1.70	22.8	2.40	14.9	3.10	10.4
1.72	22.5	2.42	14.8	3.12	10.3
1.74	22.2	2.44	14.6	3.14	10.2
1.76	21.9	2.46	14.4	3.16	10.1
1.78	21.6	2.48	14.3	3.18	9.9

5.4.5 Vibrating device To overcome minute friction, it is preferable to install a vibrating device like an electric buzzer by which a testing apparatus is suitably vibrated. It may be omitted if friction is completely removed.

5.4.6 Thermostatic chamber The thermostatic chamber is needed when the test temperature other than standard temperature is employed for measuring hardness. The thermostatic chamber shall keep the specified temperature in the tolerance of ± 2 °C. The pressure foot and a plunger shall be extended up and penetrate through the upper part of the thermostatic chamber. The part through which the plunger penetrates shall be made of the material with small thermal conductivity. The sensor for temperature measurement shall be installed at holding place of test piece or its vicinity, in the thermostatic chamber.

5.5 Test piece

5.5.1 Sampling and preparation of test piece The sampling and preparation of the test piece shall be in according with clause **8** of **JIS K 6250**. Those containing foreign matters, containing bubbles or having flaws shall not be used for the test.

5.5.2 Shape of test pieces Both surfaces of a test piece shall be smoothly flat and parallel to each other(7). This test has been supposed to compare the test pieces having the same thickness.

Note (7) The surface such as unsmoothed, curved, or rough, does not give satisfactory results. For specially formed surface, however, such as rubber roll, this method can be applied.

The international rubber hardness testing method for curved test piece is shown in Annex 1.

5.5.3 Thickness

a) **N method and H method** The standard thickness of a test pieces is 8.0 mm to 10.0 mm, however if the necessary thickness cannot be obtained, it is permissible to pile smooth and parallel test pieces up to three. Provided that the thickness of each test piece before piling shall be 2 mm or more. Even when the standard thickness cannot be obtained(8), the thickness of the test piece shall be 4.0 mm or more. The hardness in this case shall be the apparent hardness.

b) **L method** The standard thickness of a test piece is 10.0 mm to 15.0 mm, however if the necessary thickness cannot be obtained, it is permissible to pile smooth and parallel test pieces up to three. Provided that the thickness of each test piece before piling shall be 2 mm or more. Even when the standard thickness cannot be obtained(8), the thickness of the test piece shall be 6.0 mm or more. The hardness in this case shall be the apparent hardness.

c) **M method** The standard thickness of a test piece is (2.0 ± 0.5) mm. Even when the standard thickness cannot be obtained(8), the thickness of the test piece shall be 1.0 mm or more. The hardness in this case shall be the apparent hardness.

Note (8) The apparent hardness of the test peice of which standard thickness cannot be obtained, is not coincident with the standard hardness by standard test piece.

5.5.4 Measuring surface dimensions

a) **N method, H method, and L method** The measuring surface dimension of a test piece shall be large enough to measure at the point which is apart from edge of the test piece by at least the distance shown in table 6.

Table 6 Minimum distance from hardness measurement point (point of end ball of plunger) to test-piece edge

Unit: mm

Thickness of a test piece	Minimum distance from hardness measurement point to test-piece edge
4.0	7.0
6.0	8.0
8.0	9.0
10.0	10.0
15.0	11.5
25.0	13.0

b) **M method** The measuring surface dimension of a test piece shall be large enough to measure at the point which is apart from edge of the test piece by at least 2.0 mm. For the test piece with the thickness of 4 mm or more but the minimum distance from the edge of the test piece is under 7.0 mm, use M method intead of N method. In this case, carry out test at the point apart from edge of the test piece as far as possible. The hardness in this case shall be the apparent hardness.

5.6 Test method

5.6.1 Testing conditions Testing conditions shall be as follows.

a) The standard conditions of a laboratory shall follow clause **6** of **JIS K 6250**.

b) Storing of sample and test pieces shall follow clause **7** of **JIS K 6250**.

c) The conditioning of test pieces shall follow clause **9** of **JIS K 6250**.

d) The standard testing temperature shall follow **11.2.1** of **JIS K 6250**.

e) Other testing temperatures shall follow **11.2.2** of **JIS K 6250**.

5.6.2 Procedures Sprinkle slightly talcum powder on upper and back surfaces of a test piece to lessen friction between the end ball of a plunger and surface of a test piece. Place the test piece on the holding base of a test piece. Make the pressure foot touch with the surface of the test piece.

a) When the scale is graduated with IRHD, apply contact force to the plunger for 5 s, and adjust the scale to be 100. Then, apply indenting force for 30 s, and read directly hardness by IRHD.

b) When the scale is graduated with indented depth, apply contact force to the plunger for 5 s, and read the scale D_0. Then, apply indenting force for 30 s, and read the scale D_1. Make the difference between D_1 and D_0 of indented depth D. Convert the value of D into IRHD making use of table 3, table 4, and table 5.

c) While applying force, the slight vibration may be applied on the testing apparatus by a vibrating device to overcome the friction.

d) Carry out measurements at three points or more. Measure three times at the position where the contact point is apart by 6 mm or more.

5.7 Arrangement of test results Test test results shall be expressed by rounding the median of measured values of three points or more with the rounding interval 1 in accordance with **JIS Z 8401**, and mark the sign IRHD after it. In the case of standard hardness, after it mark "/" together with letter "S", and then mark "/" with sign as N, H, L, or M, which means the testing method. In the case of apparent hardness, after sign of IRHD mark "/" together with sign as N, H, L, or M, which means testing method.

Example 1 50 IRHD/S/N: means that standard test piece is measured by N method of international rubber hardness test, and standard hardness is 50 IRHD.

Example 2 50 IRHD/M: means that apparent hardness is 50 IRHD when measured by M method.

5.8 Record On test report, the following items shall be recorded.

a) Reference to this Standard

b) Shape and dimensions of test piece (the number of piled pieces and its thickness, if piled)

c) Test temperature

d) Sampling and preparation method of test pieces

e) Test result

f) Other items specially needed

6 Durometer hardness test

6.1 Purpose This test shall be carried out to measure durometer hardness of vulcanized rubber and thermoplastic rubber.

6.2 Range of measurement This test is devided according to the thickness and the hardness of test piece. The measuring range of each testing method is as follows.

a) **Type A durometer** The measuring range of type A durometer is of thickness 6.0 mm or more and of hardness A20 to A90.

b) **Type D durometer** The measuring range of type D durometer is of thickness 6.0 mm or more and of hardness over A90.

c) **Type E durometer** The measuring range of type E durometer is of thickness 10.0 mm or more and of hardness under A20.

d) **Type AM durometer** The measuring range of type AM durometer is of thickness 1.5 mm or over to and excluding 6.0 mm and of hardness A20 to A90.

6.3 Testing apparatus The testing apparatus is composed of the pressure foot by which the surface of test piece is impressed, the indentor which is protruded from the hole provided at the centre of pressure foot by action of a spring, and the indication mechanism to indicate the protrusion amount of indentor from pressure foot. As occasion demands, an automatic timer and a stand may be used. For the Type AM of durometer, a stand shall be surely used.

6.3.1 Pressure foot The pressure foot has a plane perpendicular to the indentor and a hole for passing through the indentor is opened at its centre. The diameter of the hole, in the case of Type A and Type O durometer, shall be 3.0 mm ± 0.1 mm, in the case of Type E durometer, be 5.4 mm ± 0.2 mm and in the case of Type AM durometer be 1.19 mm ± 0.03 mm. And the pressure foot, in the case of Type A and Type D durometer, shall have 18 mm ± 0.5 mm in outside diameter, in case of Type E durometer, be 500 mm² or more in area and in the case of Type AM durometer, be 9.0 mm ± 0.3 mm in outside diameter, as its size.

NOTE : For the Type A, Type D and Type E durometers, it is not required to use a stand, however the above-mentioned dimensions and tolerance shall be applied only when a stand is used. When a stand is not used, for the pressure foot, the distance from any place of its outer edge to the centre of indentor shall be 6 mm or more for Type A and Type D durometers and 7 mm or more for Type E durometer.

6.3.2 Indentor The shape and dimensions of the indentor are indicated in figure 2 for Type A durometer, in figure 3 for Type D durometer, in figure 4 for Type E durometer and in figure 5 for Type AM durometer. The material of indentor shall be abrasion resistant and corrosion resistant.

Unit: mm

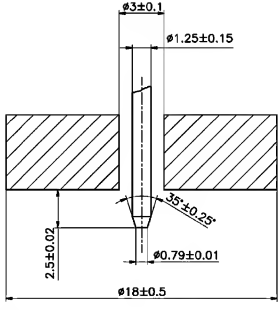


Figure 2 Shape and dimensions of Type A durometer indentor

Unit: mm

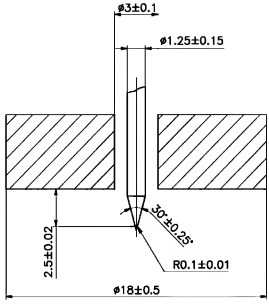


Figure 3 Shape and dimensions of Type D durometer indentor

Unit: mm

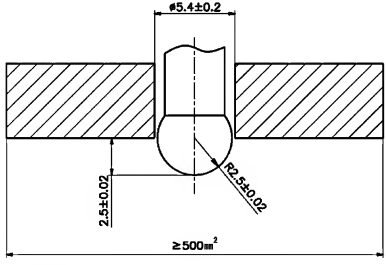


Figure 4 Shape and dimensions of Type E durometer indentor

Unit: mm

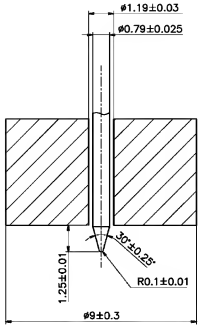


Figure 5 Shape and dimensions of Type AM durometer indentor

6.3.3 Indication mechanism The indication mechanism shall indicate the protrusion amount of indentor from the surface of pressure foot, indicate "0" in scale when protruded from the pressure foot by 2.50 mm ± 0.02 mm and indicate 100 in scale when the pressure foot in closely contacted on the flat, hard and rigid plane and the end point of indentor is on the same plane as that of the pressured surface.

6.3.4 Spring The relation between the spring force and the durometer hardness shall be as shown in formula (1) to formula (4).

a) **Type A durometer**

$$W_A = 550 + 75 \times H_A \quad (1)$$

Where, W_A : Spring force of Type A durometer (mN)

H_A : Hardness of Type A durometer

b) **Type D durometer**

$$W_D = 445 \times H_D \quad (2)$$

Where, W_D : Spring force of Type D durometer (mN)

H_D : Hardness of Type D durometer

c) **Type E durometer**

$$W_E = 550 + 75 \times H_E \quad (3)$$

Where, W_E : Spring force of Type E durometer (mN)

H_E : Hardness of Type E durometer

d) **Type AM durometer**

$$W_{AM} = 324 + 4.4 \times H_{AM} \quad (4)$$

Where, W_{AM} : Spring force of Type AM durometer (mN)

H_{AM} : Hardness of Type AM durometer

6.3.5 Automatic timing The automatic timing device may be used for the improvement of the test precision. The automatic timing device shall be activated when the pressure foot is in contact with the test piece and shall maintain the indicated value of hardness. When a stand is used, the tolerances of time shall be ±0.3 s.

6.3.6 Stand A stand may be used for better precision. A stand shall keep the durometer vertical with a weight centred on the axis of the indentor, and make the measuring surface and the indentor right angle.

6.3.6.1 Operating speed The operating speed by using a stand shall be capable of bringing contact with the test piece and the indentor without shock at a maximum speed of 3.2 mm/s.

6.3.6.2 Mass The mass loaded to the pressure foot(9) by using a stand shall be as follows.

a) For Type A and Type E durometer $1\,^{+0.1}_{0}$ kg

b) For Type D durometer $5\,^{+0.5}_{0}$ kg

c) For Type AM durometer $0.25\,^{+0.05}_{0}$ kg

Note (9) The mass loaded to the pressure foot shall be equal to the mass of the stand and the mass of the durometer.

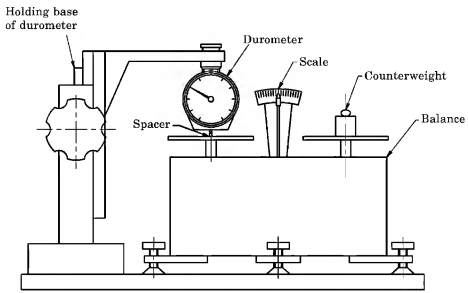
6.3.7 Calibration of spring The example of calibration apparatus of spring is shown in informative figure 1. Hold vertically the end point of indentor of durometer on the pan of balance so as not to give any interference between the balance and pressure foot via a spacer. Place a tare of the same mass of spacer mass on the pan of balance where the weight to be put beforehand. Place the weight so as to indicate a proper scale, and confirm that the force (mN) shown here stays within the tolerance of specified force. Carry out the above-mentioned calibration using the appropriate scale interval.

The calibration of spring of a durometer may be carried out with an electronic balance in addition to the chemical balance as shown in informative figure 1. In such a case, the measuring sensitivity of the force at the end point of indentor shall be within 44 mN in the case of Type D durometer and be within 8 mN in the case of Type A durometer and Type E durometer. The table for force of spring is shown in table 7.

Table 7 Spring force

Unit: mN

Scale	Spring		
	Type A/E	Type D	Type AM
0	550	—	324
10	1 300	4 450	368
20	2 050	8 900	412
30	2 800	13 350	456
40	3 550	17 800	500
50	4 300	22 250	544
60	5 050	26 700	588
70	5 800	31 150	632
80	6 550	35 600	676
90	7 300	40 050	720
100	8 050	44 500	764
Single scale	75	445	4.4
Tolerance	±80	±440	±8.8



Informative Figure 1 Example of calibration apparatus of spring

6.4 Test piece

6.4.1 Sampling and preparation of test piece The sampling and preparation of the test piece shall be in accordance with clause **8** of **JIS K 6250**. Those containing foreign matters, containing bubbles or having flaws shall not be used for the test.

6.4.2 Shape and dimensions of test pieces The thickness of a test piece for Type A and Type D durometers is 6.0 mm or more, for Type E 10.0 mm or more and for Type AM 1.5 mm or more. When it is less than the specified thickness, it may be piled for measurement. The number of test pieces to pile shall be at most three. The test result brought by piled up test piece does not generally coincide with the result by solid test piece([10]).

The measuring surface size of test piece shall be large enough to measure at the point where the end point of an indentor is apart 12.0 mm or more from the edge of the test piece for Type A and Type D, for Type E 15.0 mm or more and type AM 4.5 mm or more.

Furthermore, the test piece shall have the smooth surface of size capable of contacting closely to the pressure foot of 6.0 mm or more in the case of Type A and Type D durometers, of 9.0 mm or more in the case of Type E, of 2.5 mm or more in the case of type AM in radius from the contact point of indentor([11]).

Notes ([10]) To make comparison, it is necessary to use the test piece which has the same number for piling and the same thickness.

([11]) The surface such as unsmoothed, curved, or rough, does not give satisfactory results. For specially formed surface, however, such as rubber roll specified in **ISO 7267-2**, this method can be applied. In this case, the applicable limit of the durometer shall be definitely confirmed.

Information : Attention shall be given that the measurement value on thin test sample of soft rubber may show rather high because of the influence of the hardness of the support table.

6.5 Testing method

6.5.1 Testing conditions The test conditions shall be in accordance with **5.6.1**.

6.5.2 Procedures The operation method shall be as follows.

6.5.2.1 General Place a test piece on a rigid hard and flat surface. Hold a durometer so that the pressure foot of durometer is maintained in parallel to the surface of test piece and the indentor makes a right-angle with the surface of rubber, and contact the pressure foot to the test piece so as not to give an impact. Carry out the measurement at the position where the end point of indentor is apart from the edge of test piece by 12.0 mm or more in the case of Type A and D, by 15.0 mm or more in the case of Type E and by 4.5 mm or more in the case of Type AM.

6.5.2.2 Measurement time After the pressure foot is contacted to the test piece, carry out reading after the specified time elapses. The standard measurement time shall be 3 s for vulcanized rubber and 15 s for thermoplastic rubber. The other measurement time may be used in accordance with the agreement between the parties concerned with delivery. In such a case, it shall be mentioned in the test report.

6.5.2.3 Number of measuring point The measuring point shall be five points. Measure five times at the positions where the contact point of indentor is apart by 6 mm or more for Type A, D and E and by 0.8 mm or more for Type AM, and take the central value.

6.5.3 Calibration and confirmation

6.5.3.1 Calibration For the measuring device, the load and dimensions shall be periodically adjusted and calibrated by using suitable equipment. The calibration of load of spring shall correspond to **6.3.4**.

6.5.3.2 Confirmation method for testing apparatus by rubber test piece for confirmation hardness meter Impress a testing apparatus on a flat, hard, rigid surface and adjust so that the scale indicates 100. Confirm the durometer by using the rubber test piece for confirming hardness meter of about 30 IRHD to 90 IRHD. Store the rubber test piece for confirming hardness meter in a suitable container after being lightly sprinkled with talcum powder in order to avoid the change from light, heat, oil or grease. For the rubber test piece for confirming hardness meter, six types or more of hardness should be prepared. The existence of change in these rubber test pieces for confirming hardness meter should be confirmed by using the international rubber hardness meter at intervals of not exceeding six months. It is recommended that the durometer to be used in usually confirmed by using the rubber test piece for confirming hardness meter every week.

6.6 Arrangement of test results The test results shall be expressed by rounding the median of measured values of five points with the rounding interval 1 in accordance with **JIS Z 8401**, and the sign A in the case of Type A durometer hardness test, the sign D in the case of Type D durometer test, the sign E in the case of Type E durometer test, the sign AM in the case of Type AM durometer test is marked in the front of the numerical value. In the case of standard hardness, furthermore the sign "/" and the sign S are marked at the rear.

Example 1. A 45/s : means that in the Type A durometer hardness test, the measured hardness of standard test piece by standard test method is 45.

Example 2. E 60 : means that in the Type E durometer hardness test, the measured apparent hardness of non-standard test piece and/or by non-standard test method is 60.

6.7 Record For test report, the following items shall be recorded.

a) Reference to this Standard

b) Detail of sample

1) Detail of sample and whole detail in relation to the sample

2) Detail of compounding contents and vulcanization conditions (if known)

3) Shape and dimensions of test piece (the number of piled pieces and its thickness, if piled)

c) Detailed of test

1) Tests temperature and, when humidity influences the hardness of sample, test humidity

2) testing apparatus

3) Time required from the preparation of test piece to the measurement of hardness

4) Other measuring method which is different from the specification

5) Detail of matters not specified in this Standard and matters possible to influence the result

d) Test results

1) Durometer hardness (if needed, all values of five measured values)

2) In the case of exception of standard measurement time, its measurement time

e) Date of test

7 IRHD pocket hardness test

7.1 Purpose This test shall be carried out to obtained the international rubber hardness degree of vulcanized rubber and thermoplastic rubber by using the IRHD pocket hardness meter. The test of international rubber hardness degree by using a pocket hardness meter is the simplified method to be used for process control and the like.

7.2 Testing apparatus

7.2.1 Outline of testing apparatus The testing apparatus is composed of the pressure foot by which the surface of test piece is impressed, the indentor which is protruded from the hole provided at the centre of pressure foot by action of a spring, and the indication mechanism to indicate the protrusion amount of indentor from pressure foot.

7.2.2 Pressure foot The pressure foot is a square of 20 mm ± 2.5 mm, has a perpendicular plane to indentor and has a hole of 2.5 mm ± 0.5 mm in diameter opened at the center for passing through the indentor.

7.2.3 Indentor The shape dimensions of indentor shall be semispherical of 1.575 mm ± 0.025 mm in diameter and as shown in figure 6.

Unit: mm

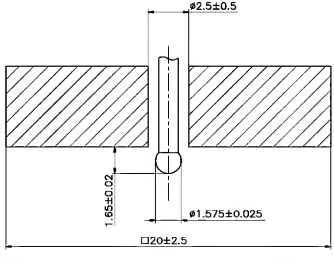


Figure 6 Shape and dimensions of indentor of IRHD pocket meter

7.2.4 Indication mechanism The indication mechanism can read conveniently the international rubber hardness degree by IRHD according to the protrusion amount of indentor from pressure foot. When the indentor protrudes from the pressure foot by 1.65 mm, it indicates 30 IRHD, and when the pressure foot is closely contacted on a smooth and flat plane and the end point of indentor is on the same plane as the pressure foot, it indicates 100 IRHD.

7.2.5 Spring The spring can apply force of 2.65 N ± 0.15 N to an indentor in the range from 30 IRHD to 100 IRHD.

7.3 Test piece

7.3.1 Sampling and preparation of test piece The sampling and preparation of the test piece shall be in accordance with clause **8** of **JIS K 6250**. Those containing foreign matters, containing bubbles or having flaws shall not be used for the test.

7.3.2 Shape and dimensions of test piece The thickness of test piece shall be 6 mm or more. When it is less than the specified thickness, it may be piled up for measurement. The number of test pieces to pile shall be at most three. The test result brought by piled up test piece does not generally coincide with the result by solid test piece(10).

The measuring surface size of test piece shall be large enough to measure at the point where the end point of an indentor is apart from the end of test piece by 12 mm or more. Furthermore, the test piece shall have the smooth surface being large enough to contact closely to the pressure foot of hardness meter(12).

Note (12) The surface such as unsmoothed, curved, or rough, does not give satisfactory results. For specially formed surface, however, such as rubber roll specified in **ISO 7267-1**, this method can be applied. In this case, the applicable limit of the IRHD pocket hardness meter shall be definitely confirmed.

7.4 Testing method

7.4.1 Testing conditions The testing conditions shall be in accordance with **5.6.1**

7.4.2 Procedures The operation method shall be as follows.

7.4.2.1 General Place a test piece on a rigid, hard and flat surface. Hold on IRHD pocket hardness meter so that the pressure foot of IRHD pocket hardness meter is maintained in parallel to the surface of test piece and the indentor makes a right-angle with the surface of rubber, and contact the pressure foot to the test piece so as not to give an impact. Carry out the measurement at the position where the end point of indentor is apart from the end of test piece by 12 mm or more.

7.4.2.2 Measurement time After the pressure foot is contacted to the test piece, carry out reading after the specified time elapses. The standard measurement time shall be 3 s for vulcanized rubber and 15 s for thermoplastic rubber. The other measurement time may be used in accordance with the agreement between the parties concerned with delivery. In such a case, it shall be mentioned in the test report.

7.4.2.3 Number of measuring point The measuring point shall be five points. Measure five times at the position where the contact point of indentor is apart by 6 mm or more, and take the median.

7.4.3 Calibration and confirmation

7.4.3.1 Calibration For the measuring device, the load and dimensions shall be periodically calibrated by using suitable equipment. When the IRHD pocket hardness meter is calibrated by mechanical means, follow the instruction of manufacturer.

7.4.3.2 Confirmation method for testing apparatus by rubber test piece for confirming hardness meter Impress a testing apparatus on a flat, hard, rigid surface and adjust so that the scale indicates 100 IRHD. Confirm the IRHD pocket hardness meter by using the rubber test piece for confirming hardness meter of about 30 IRHD to 90 IRHD. Store the rubber test piece for confirming hardness meter in a suitable container after being sprinkled with talcum powder in order to avoid the change by light, heat, oil or grease. For the rubber test piece for confirming hardness meter, six types or more of hardness should be prepared. The existence of change in these rubber test pieces for confirming hardness meter should be confirmed by using the international rubber hardness meter at intervals of not exceeding six months. It is recommended that the IRHD pocket hardness meter to be used is usually confirmed by using the rubber test piece for confirming hardness meter every week.

7.5 Arrangement of test results The test results shall be expressed by rounding the median of measured values of five points with the rounding interval 1 in accordance with **JIS Z 8401**, and the sign of IRHD is marked at the rear of numerical value, and in the case of standard hardness, the signs "/" and the sign P indicating the kind of test are marked at the rear of it. In the apparent hardness, the sign "/" and the sign P indicating the kind of test are marked in the rear of the sign of IRHD.

Example 1. 50 IRHD/S/P : means that the standard hardness is 50 IRHD when the standard test piece is measured by using IRHD pocket hardness meter.

Example 2. 50 IRHD/P : means that the apparent hardness is 50 IRHD when the non-standard test piece is measured by using IRHD pocket hardness meter.

7.6 Record For test report, the following items shall be recorded.

a) Reference to this Standard

b) Detail of sample

1) Detail of sample and whole detail in relation to the sample

2) Detail of compounding contents and vulcanization conditions (if known)

3) Shape and dimensions of test piece (the number of piled pieces and its thickness, if piled)

c) Detail of test

1) Test temperature and, when humidity influences the hardness of sample, test humidity

2) Testing apparatus

3) Time required from the preparation of test piece to the measurement of hardness

4) Other measuring method which is different from the specification

5) Detail of matters not specified in this Standard and matters possible to influence the result

d) Test results

1) IRHD pocket hardness (if needed, all values of five measurement values)

2) In the case of exception of standard measurement time, its measurement time

e) Date of test

Annex A (normative)

Relation between international rubber hardness degree and indentation depth

1 Scope This Annex specifies the rubber hardness expressed as the international rubber hardness degree (IRHD) and the indentation depth.

2 Relation between international rubber hardness degree and indentation depth The relation between the indentation depth and the international rubber hardness degree (IRHD) is based on the following two points.

a) When impressing a ball to a perfectly elastic isotropic material, the following formula is established (1).

$$D = 0.615 \times R^{-0.48} \times \left[\left(\frac{F}{E} \right)^{0.74} - \left(\frac{f}{E} \right)^{0.74} \right]$$

where, D : indentation depth (difference between the indentation depth of ball by the total indenting force and the indentation depth of ball by contacting force) (mm)

R : Radius of ball (mm)

f : Contact force of ball (N)

F : Total indenting force of ball (N)

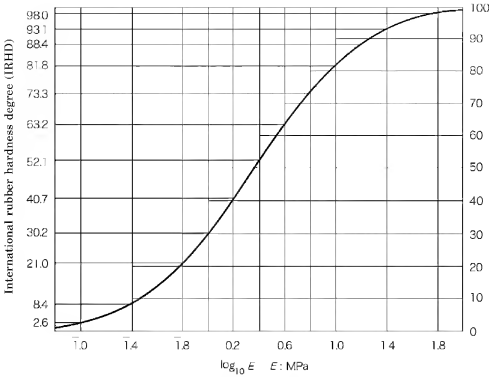
E : Young's modulus of rubber material (MPa)

b) The relation between $\log_{10}E$ and the international rubber hardness degree (IRHD) defined as follows are determined as Annex A figure 1, Annex A figure 2 and Annex A figure 3 by using the normal integrated probability density curve.

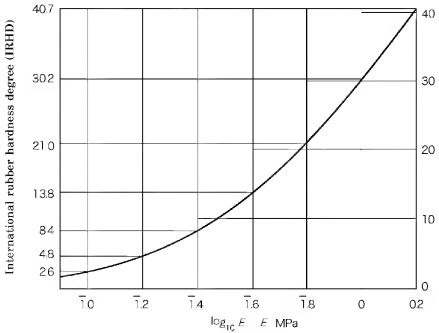
1) Young's modulus at midpoint of curve : $\log_{10}E = 0.364$

2) Maximum slope of IRHD to $\log_{10}E$: 57 IRHD

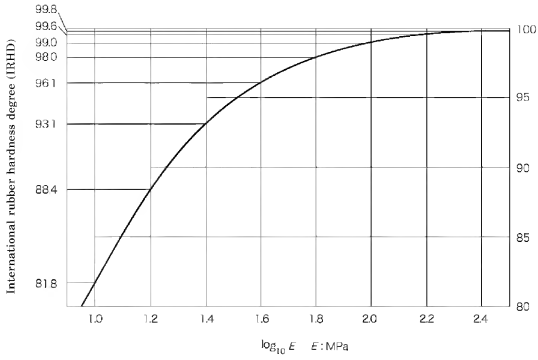
Note (1) Scott, J.R., *Physical Testing of Rubbers*, MacLaren and Sons, London, 1965



Annex A Figure 1 Relation between $\log_{10}E$ and IRHD (3 IRHD to 100 IRHD)



Annex A Figure 2 Relation between $\log_{10}E$ and IRHD (3 IRHD to 40 IRHD)



Annex A Figure 3 Relation between $\log_{10}E$ and IRHD (80 IRHD to 100 IRHD)

Annex 1 (normative)

Method for obtaining international rubber hardness degree for curved test piece

1 Scope This Annex specifies the testing method for obtaining the international rubber hardness degree. The measured values obtained by this method are always treated as an apparent hardness (1).

Note (1) Generally, these tests are carried out directly on products, so that the thickness of rubber is not constant, an in many cases, the lateral distance from the end ball of a plunger to the edge of sample is smaller than the smallest distance shown **5.5.4** of the text, and the influence owing to the distance from the edge is not negligible.

Therefore, the measured values resulted from these methods do not coincide with the values obtained by the measurements of the plate-type test pieces with flat parallel surfaces and the same thickness as that of standard test pieces or products which are specified in N method, H method, L method and M method.

This means that, the results obtained by measuring curved surface are the peculiar measurements which are applicable only to the test pieces or the products having special shape and special dimensions and further being kept in special method. In extreme case, these measured values show discrepancy of 10 IRHD from the standard hardness. The measured values on the surface buffed to eliminate covered cloth or treated specially, shows a little difference value from the value on flat surface which has been finished with molding.

Information : The measuring method of the hardness of rubber-covered rollers are specified by the following standards.

ISO 7267-1 : 1997 *Rubber-covered rollers—Determination of apparent hardness—Part 1 : IRHD method*

ISO 7267-2 : 1986 *Rubber-covered rollers—Determination of apparent hardness—Part 2 : Shore-type durometer method*

ISO 7267-3 : 1995 *Rubber-covered rollers—Determination of apparent hardness—Part 3 : Pusey and Jones method*

2 Type of testing method

a) CN method (normal size curved surface test for normal hardness)

b) CH method (normal size curved surface test for high hardness)

c) CL method (normal size curved surface test for low hardness)

d) CM method (microsize curved surface test for normal hardness)

3 General CN method, CH method, CL method, and CM method are the modified N method, H method, L method, and M method for the purpose of making them applicable to the test piece whose target surface is curved, and there are the following two cases.

a) Test piece or sample is large enough to place the hardness testing apparatus on it.

b) Test piece or sample is so small that it shall be placed on a holding base together with a hardness testing apparatus. The case where the sample is put on a flat sample base which makes one body with a testing apparatus, is included in this case.

4 Testing apparatus The testing apparatus shall be in accordance with **5.4** in the text and the following.

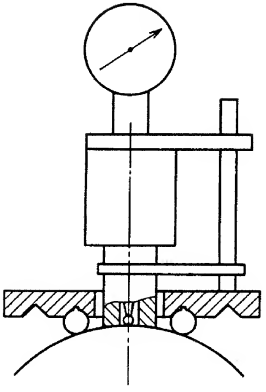
4.1 Testing apparatus for cylindrical surface of 50 mm or more radius As shown in Informative reference figure 1, the bottom base of the testing apparatus has a hole through which annular pressure foot can penetrate, for the measurement even when sample is put under the base.

There are two cylindrical surfaces which are parallel each other under the base, and these are parallel to the horizontal surface of the base. The diameter of these cylinders and the distance between them shall be suitable for setting up testing apparatus on the target curved surface of sample. Alternatively, the base, on which adjustable legs with universal joints are attached to comply with the target curved surface, may be used. An example of constitution of the testing apparatus shall be shown in Annex 1 figure 1.

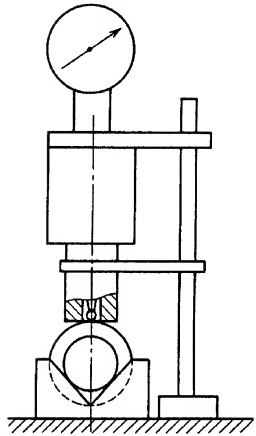
4.2 Testing apparatus for two-way curved surface of 50 mm or more radius The testing apparatus with adjustable legs with universal joints shown in **4.1** of Annex 1 shall be used.

4.3 Testing apparatus for cylindrical surface and two-way curved surface of 4 mm to 50 mm radius When target surface is too small to set a testing apparatus on it, as shown in Annex 1 figure 2, fix test piece or sample using a special jig, V-block or the like, and set the plunger to be perpendicular onto the target surface. When a small test piece is fixed on a sample table, wax may be used.

4.4 Testing apparatus for small type O-ring and curved sample of 4 mm or less radius In these cases, hold a test piece on the table of testing apparatus using a suitable jig, block, wax or the like. Carry out measurement using a testing apparatus of M method. The test piece having the minimum radius of 0.8 mm or less cannot be measured.



Annex 1 Figure 1 Example of setting a testing apparatus for sample with large diameter



Annex 1 Figure 2 Example of setting a testing apparatus for sample with small diameter

5 Test pieces The test pieces are the products or the pieces prepared by cutting the products. The sampling and preparation of test pieces shall be in accordance with **5.5.1** of the text. The bottom side of the test piece which has been cut out shall be held with suitable method and measured. In case of the target surface is covered with cloth, it must be ground before testing. In order to recover it from the influence by surface grinding, allow it to stand for 16 h or more under standard condition of laboratory, and then carry out conditioning under standard condition according to **5.6.1 c)** of the body. This duration may be included in the duration for recovering.

6 Testing method The testing method shall be in accordance with **5.6** of the text.

7 Arrangement of test results The test results shall be expressed by rounding the median of measured values of three points or more with the rounding interval 1 in accordance with **JIS Z 8401**, and then, mark sign IRHD after the value. After that, mark sign "/", and then mark CN, CH, CL, or CM which means testing method.

Example : 50 IRHD/CM : means that a curved test piece is measured by CM method of international rubber hardness curved-surface test, and the hardness is 50 IRHD.

8 Record The record shall be in accordance with **5.8** of the text.

Annex 2 (informative)
Precision of test

Introduction This Annex (informative) has been prepared based on clause **13** of **ISO 48** *Rubber, vulcanized or thermoplastic—Determination of hardness (hardness between 10 IRHD and 100 IRHD)* published in 1994 to supplement the matters related to the text and not to constitute the provisions of this Standard.

1 General The precision calculations to provide the Interlaboratory Test Programme (ITP) and repeatability in single-laboratory and reproducibility in interlaboratory were performed in accordance with **ISO/TR 9272** : 1986. The concepts of precision and terms are in accordance with this **ISO/TR 9272**.

2 Details of test

2.1 Contents of ITP Five ITPs were organized and conducted by Statens Provningsanstalt in Sweden between 1985 and 1989. Vulcanized test pieces were prepared in one laboratory, sent to all the participants and tested. The details of five ITPs are as follows.

Medium-hardness rubber, N method:	Test pieces of four rubber compounds, hardness range 30 IRHD to 85 IRHD, 26 laboratories. Hardness measurement by N method on each compound on each of two days, one week apart was performed for three times and the median of the three was used for the precision analysis as the test result.
Medium-hardness rubber, M method:	Test pieces of four rubber compounds, hardness range 30 IRHD to 85 IRHD, 26 laboratories. Hardness measurement by M method on each compound on each of two days, one week apart was performed for three times and the median of the three was used for the precision analysis as the test result.
High-hardness rubber, N method:	Test pieces of three rubber compounds, hardness range 85 IRHD to 100 IRHD, 12 laboratories. Hardness measurement by N method on each compound on each of two days, one week apart was performed for five times and the median of the five was used for the precision analysis as the test result.

High-hardness rubber, H method:	Test pieces of three rubber compounds, hardness range 85 IRHD to 100 IRHD, 12 laboratories. Hardness measurement by H method on each compound on each of two days, one week apart was performed for three times and the median of the three was used for the precision analysis as the test result.
Low-hardness rubber, L method:	Test pieces of one rubber compound, low hardness, 5 laboratories. Hardness measurement on each of two days, one week apart was performed by L method for three times and the median of the three was used for the precision analysis as the test result.

2.2 Precision type The precision obtained by this ITP is Type 1 precision; that is, the test pieces were prepared at one time and provided to all laboratories. For the low-hardness rubber by L method, the values in the table should be used with caution due to the small number of laboratories.

3 Precision results The final precision results are as shown in Annex 2 table 1 to Annex 2 table 5. Symbols in tables are as follows.

r : repeatability in single laboratory (IRHD)

(r) : relative repeatability in single laboratory (%)

R : reproducibility in interlaboratory (IRHD)

(R) : relative reproducibility in interlaboratory (%)

Annex 2 Table 1 Type 1 precision for measurement of medium-hardness test piece by N method

Sample	Median	Single laboratory		Interlaboratory	
		r	(r)	R	(R)
A	31.5	1.29	4.08	2.98	9.47
B	47.1	1.23	2.61	2.68	5.68
C	66.6	1.65	2.48	4.47	6.71
D	86.5	2.32	2.68	3.49	4.03
Pool value	–	–	2.89	–	5.99

Annex 2 Table 2 Type 1 precision for measurement of medium-hardness test piece by M method

Sample	Median	Single laboratory		Interlaboratory	
		r	(r)	R	(R)
A	36.6	1.57	4.29	5.82	15.9
B	50.9	2.31	4.55	5.44	10.7
C	64.9	4.89	7.54	7.47	11.5
D	88.6	4.76	5.38	6.80	7.68
Pool value	–	–	6.16	–	10.7

Annex 2 Table 3 Type 1 precision for measurement of high-hardness test piece by N method

Sample	Median	Single laboratory		Interlaboratory	
		r	(r)	R	(R)
A	85.8	0.78	0.91	3.53	4.11
B	93.4	1.11	1.19	2.96	3.17
C	98.5	0.33	0.34	1.45	1.47
Pool value	–	–	0.87	–	3.09

Annex 2 Table 4 Type 1 precision for measurement of high-hardness test piece by H method

Sample	Median	Single laboratory		Interlaboratory	
		r	(r)	R	(R)
A	87.0	0.96	1.03	3.12	3.41
B	94.2	1.00	1.07	2.15	2.31
C	98.7	0.71	0.76	1.03	1.10
Pool value	–	–	0.90	–	2.46

Annex 2 Table 5 Type 1 precision for measurement of low-hardness test piece by L method

Sample	Median	Single laboratory		Interlaboratory	
		r	(r)	R	(R)
A	33.0	0.20	0.61	2.00	6.04

Annex 3 (informative)

Comparison table between JIS and corresponding International Standards

JIS K 6253 : 2006 *Rubber, vulcanized or thermoplastic—Determination of hardness*

ISO 48 : 1994 *Rubber, vulcanized or thermoplastic—Determination of hardness (hardness between 10 IRHD and 100 IRHD)* and Amendment 1 (1999)
ISO 7619-1 : 2004 *Rubber, vulcanized or thermoplastic—Determination of indentation hardness—Part 1 : Durometer method (Shore hardness)*
ISO 7619-2 : 2004 *Rubber, vulcanized or thermoplastic—Determination of indentation hardness—Part 2 : IRHD pocket meter method*

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, Annex Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
1 Scope	Specifies the testing methods to measure the hardness of rubber.	**ISO 48** **ISO 7619-1** **ISO 7619-2**	1 1 1	Specifies the testing methods to measure the hardness of rubber.	MOD/alteration	In **JIS**, the three standards such as **ISO 48** (International rubber hardness), **ISO 7619-1** (Durometer hardness) and **ISO 7619-2** (IRHD pocket hardness) are made to be one standard.	The convenience of users is considered.
2 Normative references	**JIS K 6200**	**ISO 48**	2	—	MOD/addition	**JIS** for terms is added.	This is added for understanding easily, and there is no difference substantially.
	JIS K 6250	**ISO 48**	2	**ISO 471** **ISO 1826** **ISO 3383** **ISO 4661-1**	IDT	These four **ISO** standards are unified to **ISO 23529**.	
		ISO 7619-1	2	**ISO 23529**	IDT		
		ISO 7619-2	2	**ISO 48** **ISO 23529**	IDT		

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, Annex Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
2 Normative references	**JIS Z 8401**	—	—	—	MOD/addition	**JIS** for rounding-off of numerical value is added.	This is added because of being necessary for **JIS**. There is no difference substantially.
		ISO 48	2	**ISO TR/9272**	MOD/deletion	This is deleted because **ISO TR/9272** refers to the clause of precision of IRHD.	Alteration of construction. When the precision of all testing methods are gathered, these will be quoted.
3 Definitions	Specifies the definitions of main terms.	**ISO 48**	4	Approximately equal to **JIS**.	MOD/addition	The three standards are unified, therefore the hardness in **ISO 7619-1** and **ISO 7619-2** are also mentioned as the definition.	This is added for understanding easily, and there is no difference substantially.
4 Type of test	The type of test, the range of measurement and the conditions of test piece are indicated.	—	—	—	MOD/addition	—	**JIS** is corresponded to the three standards of **ISO** standard, and this is added for understanding the whole of standard easily, and there is no difference substantially.
5 International rubber hardness degree test							
5.1 Purpose		**ISO 48**	1	Identical with **JIS**.	IDT	—	—
5.2 Principle		**ISO 48**	3	Identical with **JIS**.	IDT	—	—

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, Annex Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
5.3 Range of measurement		**ISO 48**	1	Identical with **JIS**.	IDT	—	—
5.4 Testing apparatus	N, H, L, M methods	**ISO 48**	5.1 5.2	Method N, H, L, M Method CN, CH, CL, CM	IDT MOD/alteration	— The hardness of curved surface is made to Annex 1.	— The specification of hardness of curved test piece is included only in **ISO 48** among the three corresponding International Standards and the construction of the text of **JIS** is made to be easily understood by taking this as Annex.
5.5 Test piece		**ISO 48**	6.1	Approximately equal to **JIS**.	MOD/addition	It is added that the test piece mixed with foreign matter, etc. shall not be used.	This is added for understanding easily, and there is no difference substantially.
5.6 Test method		**ISO 48** **ISO 48/Amd.1**	7, 8, 9 and 10	Identical with **JIS**.	IDT	—	—
5.7 Arrangement of test results		**ISO 48**	11 12	Approximately equal to **JIS**.	MOD/addition	The normative reference of "Guide to the rounding of numbers" is added.	This is added for understanding easily, and there is no difference substantially.
5.8 Record		**ISO 48**	14	Identical with **JIS**.	IDT	—	—
6 Durometer hardness test							

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, Annex Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
6.1 Purpose			1		IDT	—	—
6.2 Range of measurement	Type and range of measurement of durometer	**ISO 7619-1**	1 and 3	The type and range of measurement of durometer are described.	MOD/alteration	The nominal designation of Type AO is altered to E.	This is the alteration of nominal designation and there is no difference substantially.
6.3 Testing apparatus		**ISO 7619-1**	4	Identical with **JIS**.	IDT	—	—
6.3.1 Pressure foot	Shape and dimensions of pressure foot	**ISO 7619-1**	4.1.1	Approximately equal to **JIS**.	MOD/addition	The dimension of pressure foot in the case of no using a stand is specified.	This is an important matter, therefore, the addition to **ISO** standard will be proposed.
6.3.7 Calibration of spring	Force of spring and its tolerance	**ISO 7619-1**	4.4	Approximately equal to **JIS**.	MOD/addition	The explanatory text of informative figure 1 (example of spring calibration apparatus) is added.	This is added for understanding easily.
					MOD/alteration	The tolerance spring force in table 7 are altered.	The usual tolerances are adopted as suiting to actual circumstance. The alteration of **ISO** standard will be proposed.
6.4 Test piece		**ISO 7619-1**	5	Approximately equal to **JIS**.	MOD/addition	The sampling and preparation of test piece are added.	This is added because of being necessary for **JIS**. The addition to **ISO** standard will be proposed.
6.5 Testing method		**ISO 7619-1**	6 7 8	Identical with **JIS**.	IDT	—	—
6.6 Arrangement of test results		**ISO 7619-1**	7.3	Approximately equal to **JIS**.	MOD/addition	The normative reference of "Guide to the rounding of numbers" is added.	This is added for understanding easily, therefore, there is no difference substantially.

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, Annex Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
6.7 Record		**ISO 7619-1**	9	Identical with **JIS**.	IDT	—	—
7 IRHD pocket hardness test							
7.1 Purpose	Purpose of test	**ISO 7619-2**	1 3	Identical with **JIS**.	IDT	—	—
7.2 Testing apparatus		**ISO 7619-2**	4	Identical with **JIS**.	IDT	—	—
7.3 Test piece		**ISO 7619-2**	5	Approximately equal to **JIS**.	MOD/addition	The sampling and preparation of test piece are added.	This is added because of being necessary for **JIS**. The addition to **ISO** standard will be proposed.
7.4 Testing method			6, 7, 8	Identical with **JIS**.	IDT	—	—
7.5 Arrangement of test results	Arrangement and indication method of measured values		7.3	Arrangement of measured values	MOD/addition	The normative reference of "Guide to the rounding of numbers" is added. **JIS** specifies the indication method.	This is added for understanding easily, and there is no difference substantially.
7.6 Record			9		IDT	—	—
Annex A (normative)	Relation between international rubber hardness degree and indentation method	**ISO 48** **ISO 48/Amd.1**	Annex A (normative)	Approximately equal to **JIS**.	MOD/alteration	The errors of the interval of ordinate and the numerical value of abscissa in figure 1, figure 2 and figure 3 of this Annex are corrected.	The modification of **ISO** standard is proposing.

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: text, Annex Indication method: dotted underlines or continuous sidelines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
Annex 1 (normative)	Method for obtaining rubber hardness degree for curved test piece	**ISO 48**	1 5.2 6.2	**Approximately equal to JIS.**	MOD/alteration MOD/addition	**The matters mentioned in the text of ISO 48 is made to Annex in JIS.** Figure 1 and figure 2 of Annex are added as the example of testing apparatus.	This is the alteration of construction and there is no difference in technical content. This is added for understanding easily and there is no difference in technical content.
Annex 2 (informative)	Precision of test	**ISO 48**	13	Precision of test	MOD/alteration	—	This is a reference information, therefore, it is made to Annex (informative).

Designated degree of correspondence between **JIS** and International Standards : MOD

NOTES 1 Symbols in sub-columns of classification by clause in the above table indicate as follows :

- IDT : Identical in technical contents.
- MOD/deletion : Deletes the specification item(s) or content(s) of International Standard.
- MOD/addition : Adds the specification item(s) or content(s) which are not included in International Standard.
- MOD/alteration : Alters the specification content(s) which are included in International Standard.

2 Symbol in column of designated degree of correspondence between **JIS** and International Standards in the above table indicates as follows :

- MOD: Modifies International Standards.

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